MLX300
HARDWARE INSTALLATION, SOFTWARE UPGRADE AND OPTIONS

INSTRUCTIONS

Upon receipt of the product and prior to initial operation, read instructions thoroughly, and retain for future reference.
Summary of Warning Information

This manual is provided to help users establish safe conditions for operating the equipment. Specific considerations and precautions are also described in the manual, but appear in the form of Dangers, Warnings, Cautions, and Notice.

It is important that users operate the equipment in accordance with this instruction manual and any additional information which may be provided by Yaskawa. Address any questions regarding the safe and proper operation of the equipment to Customer Support.

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the manipulator.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

- **DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

- **WARNING** Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

- **CAUTION** Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

- **NOTICE** NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.
Items described as “CAUTION” may result in a serious accident in some situations.

**WARNING**

- This instruction manual is intended to explain the MLX300 software and operating instructions. Make sure to read and understand this manual thoroughly before installing and operating the MLX300.

Failure to read and understand this manual may result in serious injury or death.

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this Warning may result in electric shock or serious injury.
WARNING

• Before operating the manipulator, check that servo power is turned OFF by pressing a EMERGENCY STOP button. When the servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.

Failure to observe this instruction may cause improper or unintended movement of the Manipulator, which may result in personal injury.

• Confirm that no person is present in the Manipulator's operating range and that the operator is in a safe location before:
  – Turning ON the Controller power
  – Moving the Manipulator by using the Pendant
  – Running the system in the CHECK mode
  – Performing automatic operations

Failure to observe this instruction may result if a person enters the Manipulator's operating range during operation. Immediately press an EMERGENCY STOP button whenever there is a problem.

• Read and understand the Explanation of the Warning Labels before operating the Manipulator.
CAUTION

• Read and understand the Explanation of Warning Labels in the Controller instructions.

Yaskawa is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

• Perform the following inspection procedures prior to conducting Manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing are performed.
  – Check for problems with Manipulator movement.
  – Check for damage to insulation and sheathing of external wires.

CAUTION

• Always return the Pendant to the hook on the cabinet of the Controller after use.

The Pendant can be damaged if it is left in the Manipulator's work area, on the floor, or near fixtures.

NOTICE

• The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.

• Yaskawa may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

• If your copy of the manual is damaged or lost, contact customer support to order a new copy. Be sure to tell the representative the manual number listed on the front cover.

• To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” or “CAUTION”.
CAUTION

All operators, programmers, maintenance personnel, supervisors, and anyone working near the system must become familiar with the operation of this equipment.

Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this equipment should be permitted to program, or maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the equipment to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Check the EMERGENCY STOP button at the operator station for proper operation before programming. The equipment must be in EMERGENCY STOP (E-Stop) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
- Any modifications to the Controller unit can cause severe personal injury or death, as well as damage to the Manipulator. Do not make any modifications to the Controller unit. Making any changes without the written permission from Yaskawa will void the warranty.
- Some operations require standard passwords and some require special passwords.
- The equipment allows modifications to the software for maximum performance. Care must be taken when making modifications. All modifications made to the software will change the way the equipment operates and can cause severe personal injury or death, as well as damage parts of the system. Double check all modifications under every mode of operation to ensure that the changes have not created hazards or dangerous situations.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the Controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.

Improper connections can damage equipment. All connections must be made within the standard voltage and current ratings of the equipment.
Safeguarding Tips

**CAUTION**

All operators, programmers, maintenance personnel, supervisors, and anyone working near the system must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this equipment, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this equipment.

- Improper connections can damage the equipment. All connections must be made within the standard voltage and current ratings of the equipment.
- The system must be placed in EMERGENCY STOP (E-Stop) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-2012, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety barriers
- Door interlocks
- EMERGENCY STOP button located on the operator station

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

Mechanical Safety Devices

**CAUTION**

The safe operation of this equipment is ultimately the users responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-2012 safety standards, and other local codes that may pertain to the installation and use of this equipment.

Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety barriers
- Door interlocks
- EMERGENCY STOP button located on the operator station

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.
Safety
Maintenance Safety

Maintenance Safety

**WARNING**

- Turn the power OFF, disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

Perform only the maintenance described in this manual. Maintenance other than specified in this manual should be performed only by Yaskawa-trained, qualified personnel.

National Safety Standard

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association  
900 Victors Way  
P.O. Box 3724  
Ann Arbor, Michigan 48106  
TEL: (734) 994-6088  
FAX: (734) 994-3338  
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment.

NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Definition of Terms Used Often in This Manual

The MOTOMAN is a Yaskawa industrial robot product.

The MOTOMAN usually consists of the Manipulator, Controller, Programming Pendant, and supply cables.

The following equipment is designated as follows in this manual:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
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<tbody>
<tr>
<td>DX200 or YRC1000 Controller</td>
<td>Controller</td>
</tr>
<tr>
<td>Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Pro-face Pendant or Allen Bradley MobileView</td>
<td>MLX300 Pendant</td>
</tr>
<tr>
<td>Programming Pendant or Pro-face Pendant</td>
<td>Pendant</td>
</tr>
<tr>
<td>Personal Computer or PC or Desktop or Laptop</td>
<td>Computer</td>
</tr>
</tbody>
</table>

Descriptions of the Programming Pendant keys, buttons, and displays are shown as follows: In the explanation of the operation procedure, the expression “Select ・・・” means that the cursor is moved to the object item and the [Select] button is pressed, or that the item is directly selected by touching the screen.

Descriptions of keys, buttons, and screens are shown as follows:

<table>
<thead>
<tr>
<th>Manual Designation</th>
<th>Buttons</th>
<th>Mode Key</th>
<th>Screens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The buttons will be denoted with [ ].</td>
<td>Modes will be denoted as follows: AUTOMATIC or MANUAL mode</td>
<td>The screen displayed is denoted with { }. ex. {JOB}</td>
</tr>
</tbody>
</table>

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or bland names for each company or corporation. The indications of (R) and ™ are omitted.
Customer Support Information

If you need assistance with any aspect of the system, please contact Customer Support at the following 24-hour telephone number:

(937) 847-3200

For **routine** technical inquiries, you can also contact Customer Support at the following e-mail address:

techsupport@motoman.com

When using e-mail to contact Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

**NOTICE**

Use e-mail for **routine** inquiries only. If there is an urgent or emergency need for service, replacement parts, or information, contact Customer Support at the telephone number shown above.

Have the following information ready before you call Customer Support:

- **System**
  - MLX300

- **Primary Application**

- **Manipulator**

- **Controller**
  - YRC1000/DX200

- **Software Version**
  - (Programming Pendants "About MLX" screen. The MLX-D Version # is the PLC ladder version and the MLX-R Version # is the Controller software version.)

- **Manipulator Serial Number**
  - (Located on the Manipulator data plate)

- **Manipulator Sales Order Number**
  - (Located on the Manipulator data plate)
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1 Introduction

1.1 About This Document

This manual provides the following information:

- **Chapter 1 “Introduction”**

- **Chapter 2 “MLX300 Hardware Installation”**
  This chapter provides Hardware installation procedures.

- **Chapter 3 “MLX300 Software”**
  This chapter provides information concerning the software.

- **Chapter 4 “Collision Detection Setup”**
  Provides information concerning Collision Detection including how to set it up.

- **Chapter 5 “Soft Limits Adjustments”**
  This chapter provides information for adjusting the Soft Limits.

- **Chapter 6 “Brake Release”**
  This chapter provides information on how to release the brakes.

- **Chapter 7 “Shipping Position”**
  This chapter provides information on how to ship the Manipulator.

- **Chapter 8 “MLX300 PLC Software Version Upgrade Procedure”**
  This chapter provides information on upgrading software.

- **Chapter 9 “Motosim EG-VRC Virtual Controller Setup Procedure”**
  This chapter provides information on how to set up the Motosim EG-VRC software.

- **Appendix A**
  This appendix provides information on how to connect and disconnect Programming Pendant with software.

- **Appendix B**
  This appendix contains a list and terms that may be needed to know with this system.
1.2 System Overview

NOTICE

Once adding the MLX software to the Controller, the Controller will be known as a MLX300.

The MLX300 solution enables the user to replace the traditional Controller programming language with a PLC-based ladder programming. This creates huge benefits for companies that already have PLC programmers. It will greatly reduce the learning curve and increase the number of people who can program, maintain and service the system.

The MLX300 Hardware Installation, Software Upgrade and Options enables the user to integrate Yaskawa Manipulators with Rockwell Automation ControlLogix or CompactLogix Programmable Logic Controllers (PLC), with RSLogix 5000 development software using a customized set of MLX300 Add-On Instructions.

The MLX300 option can be added to any DX200 or YRC1000 Controller. It is basically a software programming feature that can be enabled on the Controller. This option empowers the PLC to completely control the Manipulator using ladder logic. The inherent benefit is that the motion control is still handled with the Controller with its superior kinematic algorithms.
1.3 Reference Documentation

For additional information on individual components of the Software, refer to the following documentation that is included with the system:

- Yaskawa Motoman Manipulator Manual
  - Varies by Manipulator Supplied

- Yaskawa Motoman Controller Instruction Manual
  - YRC1000 (179531-1CD)
  - DX200 (165292-1CD)

- Yaskawa Controller Maintenance Manual
  - YRC1000 (178643-1CD)
  - DX200 (165293-1CD)

- Yaskawa Operator’s Manual for the application
  - Varies by Controller and application

- Yaskawa Controller Concurrent I/O Manual
  - YRC1000 (178648-1CD)
  - DX200 (165294-1CD)

  - YRC1000 (178649-1CD)
  - DX200 (165301-1CD)

- Yaskawa MotoSim EG-VRC Operators Manual (156225-1CD)

- Yaskawa MLX300 Application Backup Manual
  - 181925-1CD

  - 180247-1CD

- Vendor manuals for system components not manufactured by Yaskawa
### 1.4 Quick Start Guide

**WARNING**

- Anyone working with the Controller and Manipulator are responsible for reading and understanding all included documents.

This Quick Start Guide is just a basic outline of the setup of the ArcWorld.

Not reading and understanding all included documents can cause death or serious injury.

<table>
<thead>
<tr>
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<th>PREPARATION (PRE-ARRIVAL)</th>
<th>PRELIMINARY RISK ASSESSMENT</th>
<th>DETERMINE LOCATION FOR INSTALL</th>
<th>PREPARATION FOR POWER CONNECTION</th>
<th>MOUNTING SPECIFICATIONS</th>
<th>TOOLING SPECIFICATIONS</th>
<th>COMPRRESSED AIR SUPPLY (IF USED)</th>
<th>TRAINING</th>
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**PHASE 2**

**RECEIVE CONTROLLER & MANIPULATOR**

<table>
<thead>
<tr>
<th>PREPARE FOR HANDLING &amp; TRANSPORTATION OF EQUIPMENT TO WORKSPACE</th>
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**PHASE 3**

**INSTALL CONTROLLER**

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<th>CONNECT PRIMARY POWER &amp; GROUND</th>
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**PHASE 4**

**INSTALL MANIPULATOR**

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<th>ATTACH MANIPULATOR CABLES TO CONTROLLER</th>
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**Note:**

- All steps marked with an '□' should be completed.
- Contact Yaskawa Academy:
  - Phone: 937-847-3307
  - Email: training@motoman.com
2 MLX300 Hardware Installation

2.1 MLX300 Hardware Configurations

**NOTICE**

The integrator or customer is responsible for performing a risk assessment on the final cell configuration.

Fig. 2-1 shows the connections of all the basic optional hardware, and Fig. 2-2 shows the hardware supplied by Yaskawa.

The Programming Pendant is only for initialization and setup before shipment to an integrator. It will not be utilized or connected for MLX300 operation. The MLX300 interface is designed so only one pendant can be connected at a time. Fig. 2-1 shows the MLX300 Pendant not having power until the Programming Pendant is disconnected and the second cable shown next to it, is connected.

*Fig. 2-1: Configuration with All Optional Hardware*
Fig. 2-2: Yaskawa Supplied Hardware
Fig. 2-3 shows the MLX300 Pendant connected and powered. In this configuration, only the MLX300 Pendant can jog the manipulator or start an Auto cycle. A PanelView is also shown, but whenever a Pendant is connected, all MLX300 screens that can initiate motion or change the manipulator configuration are disabled and cannot be viewed. It is possible to navigate to other screens to monitor status or control other non-manipulator cell functions.

*Fig. 2-3: Manipulator Control with the MLX300 Pendant*
To enable the MLX300 screens on the PanelView HMI or a computer, the MLX300 Pendant must be removed and replaced with a bypass plug, as shown in Fig. 2-4. The Pendant bypass plug provides dual channel signals to the Controllers machine safety inputs.

*Fig. 2-4: Manipulator Control with the PanelView HMI*

When all Pendants are disconnected and all MLX300 Pendant bypass plugs are connected, the PanelView HMI is able to control the cell in AUTO mode. However, the PanelView is unable to turn servos on in MANUAL mode without an enabling device.
2 MLX300 Hardware Installation

2.1 MLX300 Hardware Configurations

The system does not require a MLX300 Pendant to configure the system. Using this setup requires using a enabling device to turn on servo power in MANUAL mode. Fig. 2-5, the PanelView HMI is capable of turning on the servos and jogging the Manipulator when squeezing the enabling device.

**NOTICE**

The servos will not turn on unless the Controller detects an off-on transition of the enabling device.

*Fig. 2-5: Manipulator Control with an Enabling Device*
During system integration, it might be desirable to jog the Manipulator from a computer before installing all the hardware. However, there will be an issue turning on servo power, since the computer does not have an enabling device. There is a method available to disable the Controller communication to the Programming Pendant and using the Programming Pendants enabling device. (Refer to Appendix A)

With the Programming Pendant communication disabled, a programmer can squeeze the Programming Pendant enabling device and use the HMI on a computer to jog the Manipulator. Refer to Fig. 2-6.

Fig. 2-6: Manipulator Control with a Computer
2.2 MLX300 Pendant Options

For a typical MLX300 system, there are two teach pendants. The Programming Pendant comes with the MLX300 package. This Pendant is primarily for the initial Controller initialization and setup, which is done by Yaskawa before shipment. The Programming Pendant is disconnected for MLX300 operations.

**NOTICE**

The MLX300 motion commands do not function if the Programming Pendant is connected.

A MLX300 Pendant can be added by the integrator for MLX300 HMI operations, which includes a Manipulator program control, jogging, and teaching points.

Yaskawa provides software HMI screens for two choices; the Pro-face Pendant and the Allen Bradley MobileView Pendant. This software platform is designed to provide a seamless transition from the previous generation of MLX Controllers. Technical tutorials on how to use the MLX HMI are available on the Motoman website.

*Fig. 2-7: MLX300 Pendant Options*

The Pro-face Pendant has a 5.7 inch display and a set of buttons that jog the Manipulator. The MobileView Pendant has a 10 inch display. Both include an [EMERGENCY STOP] button and a three position servo-on enabling switch. The HMI software screens use the same layout and functionality as the PanelView display.

**NOTICE**

Turn off Controller power before connecting and disconnecting Pendants.
2.3 MLX300 Hardware Options and Requirements

2.3.1 Minimum Requirements

- ControlLogix, CompactLogix or GuardLogix processor with Ethernet/IP Port and 2MB of memory (L3x, L7x, L7xs)
- Rockwell Studio 5000 Logix Designer, version 24.00
  - When using Windows 10, version 30.00 is highly recommended
- Rockwell FactoryTalk View Studio - Machine Edition, version 7.00.00
- Pro-face, GP-Pro EX, version 4.06.300

2.3.1.1 List of Optional PLC, Pendant, and HMI Hardware

<table>
<thead>
<tr>
<th>PLC HARDWARE</th>
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<tbody>
<tr>
<td>PLC Controller</td>
</tr>
<tr>
<td>(with a minimum of 2MB of memory)</td>
</tr>
<tr>
<td>CompactLogix L3x</td>
</tr>
<tr>
<td>ControlLogix L7x</td>
</tr>
<tr>
<td>GuardLogix L7xs</td>
</tr>
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<thead>
<tr>
<th>PRO-FACE PENDANT HARDWARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro-face Pendant Kit</td>
</tr>
<tr>
<td>(Includes interface box and wallmount)</td>
</tr>
<tr>
<td>Motoman# 182097-1</td>
</tr>
<tr>
<td>Cable, 3M, 5M, 10M</td>
</tr>
<tr>
<td>Motoman# 182099-1, -2, -3</td>
</tr>
<tr>
<td>Pendant Bypas Plug</td>
</tr>
<tr>
<td>Motoman# 182052-1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRO-FACE HMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro-face Display</td>
</tr>
<tr>
<td>Any Pro-face SP5000 series</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ALLEN BRADLEY PENDANT HARDWARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MobileView Pendant</td>
</tr>
<tr>
<td>AB# 2711T-T10R1N1</td>
</tr>
<tr>
<td>Interface box</td>
</tr>
<tr>
<td>AB# 2711T-JBIP20DC</td>
</tr>
<tr>
<td>Wallmount Bracket</td>
</tr>
<tr>
<td>AB# 2711T-BRACKET</td>
</tr>
<tr>
<td>Cable, 5M, 10M, 15M</td>
</tr>
<tr>
<td>AB# 2711T-5MCABLE, -10MCABLE, -15MCABLE</td>
</tr>
<tr>
<td>Glandplate (mount for interface box)</td>
</tr>
<tr>
<td>Motoman # 143047-111</td>
</tr>
<tr>
<td>Pendant Bypas Plug</td>
</tr>
<tr>
<td>Motoman # 182086-1</td>
</tr>
<tr>
<td>Power Supply (24V, 1A), Fuse, Relay</td>
</tr>
<tr>
<td>Various Options</td>
</tr>
<tr>
<td>(Req only for YRC1000 PanelView)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ALLEN BRADLEY PANELVIEW HMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PanelView</td>
</tr>
<tr>
<td>Any PanelView 1000 or Plus 7 without the keypad</td>
</tr>
<tr>
<td>(Recommended a 10 inch display)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SERVO-ON ENABLING DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(If a MLX300 Pendant is not used with the System)</td>
</tr>
<tr>
<td>Grip switch</td>
</tr>
<tr>
<td>AB# 440J-N21TNPM</td>
</tr>
<tr>
<td>Mounting bracket</td>
</tr>
<tr>
<td>AB# 440J-A00N</td>
</tr>
</tbody>
</table>
2.4 Pendant Interface Drawings

Adding an optional Pendant is an easy task. The majority of the connection points inside the Controller can be quickly found by looking for violet jumper wires on the terminals. These wires jump the required signals when there is not an optional Pendant. Remove the jumper wires, and replace them with connections for the Pendant interface. The wiring information in this manual are also in the MLX300 drawing package.

2.4.1 Installing a Pro-Face Pendant to the DX200 Controller

*Fig. 2-8: Pro-face Pendant Interface Box Connections to DX200 Controller*

*Fig. 2-9: Pro-face Pendant Interface Wiring to DX200 Controller*
2.4.2 Installing a Pro-Face Pendant to the YRC1000 Controller

*Fig. 2-10: Pro-face Pendant Interface Box Connections to the YRC1000 Controller*

*Fig. 2-11: Pro-face Pendant Interface Wiring to the YRC1000 Controller*
2.4.3 Installing a MobileView Pendant to the DX200 Controller

Fig. 2-12: MobileView Pendant Interface Box Connections to the DX200 Controller

Fig. 2-13: MobileView Pendant Wiring to DX200 Controller
2.4.4 Adding a MobileView Pendant to the YRC1000 Controller

Fig. 2-14: MobileView Pendant Interface Box Connections to the YRC1000 Controller

Fig. 2-15: MobileView Pendant Wiring to YRC1000 Controller
2.5 Pendant Bypass Plug Drawings

If adding a MLX300 Pendant to the system, a Pendant bypass plug is required. This is needed to switch the control over to a PanelView HMI or a computer. The MLX300 Pendant needs to be removed and replaced with a bypass plug. The Pendant bypass plug jumpers the Pendants Emergency Stop and Servo-On Enabling (DSW) pins. The plug also has two jumpers for a dual channel signal to the manipulator machine safety input (GSIN #1), which detects that the bypass plug is installed. When the plug is not detected, all PanelView and computer HMI screens with MLX300 functionality are disabled and cannot be viewed.

2.5.1 Pro-Face Bypass Plug

*Fig. 2-16: Pro-face Pendant Bypass Connector Wiring*

2.5.2 MobileView Bypass Plug

*Fig. 2-17: MobileView Pendant Bypass Connector Wiring*
2.6 Enabling Device

When not using a MLX300 Pendant with the system, an enabling device is required to turn on servo power in MANUAL mode.

Fig. 2-18: Enabling Device

2.6.1 Adding an Enabling Device to the DX200 Controller

Fig. 2-19: Enabling Device Wiring to the DX200 Controller
2.6.2 Adding an Enabling Device to the YRC1000 Controller

Fig. 2-20: Enable Device Wiring to the YRC1000 Controller
2.7 External E-Stop and Safety Fence

All safety devices are wired to the safety board in the Controller. Refer to Fig. 2-21. Each safety device is dual channel. Remove the jumper wires and install the devices on the terminals shown in the next two sections.

*Fig. 2-21: Safety Breakout Board (CN219 for DX200; CN220 for YRC1000)*

---

### 2.7.1 Adding External E-Stop and Safety Gate Wiring to DX200

*Fig. 2-22: External E-Stop and Safety Gate Terminals on DX200*
2.7.2 Adding External E-Stop and Safety Gate Wiring to YRC1000

Fig. 2-23: External E-Stop and Safety Gate Terminals on YRC1000
2.8 Controller Inputs and Outputs

The MLX300 PLC program can control the DX200 Controller or YRC1000 Controller inputs and outputs.

Manipulator I/O wiring connections are in the MLX300 drawing package provided with the Manipulator.

2.8.1 DX200 Controller I/O

The DX200 I/O has 24 inputs and 24 outputs.

- **Inputs:**
  - Manipulator: 1-24 (sinking)
  - PLC: ControllerDigitalInputs.0 to .23

- **Outputs:**
  - Manipulator:
    - 1-8 (sinking)
    - 9-24 (relays)
  - PLC Outputs:
    - ControllerDigitalOutputs 0 to .23

Also, refer to the “Universal I/O Signal Assignment” section of the DX200 Instructions manual (165292-1CD.)

The Controller universal inputs and outputs can be accessed with the ControllerDigitalInput and the ControllerDigitalOutput tags, which are aliased to internal tags. Refer to Fig. 2-24.

*Fig. 2-24: Controller Input and Output Tags*

**NOTICE**

The Controller universal input and output numbers are offset by 1. For example, universal output #1 is controlled by ControllerDigitalOutputs.[0].
2.8.2 YRC1000 Controller I/O

The YRC1000 I/O has 16 inputs and 16 outputs.

- **Inputs:**
  - Manipulator: 9-24 (sinking)
  - PLC: ControllerDigitalInputs.8 to .23

- **Outputs:**
  - Manipulator:
    - 9-16 (sinking)
    - 17-24 (relays)
  - PLC Outputs:
    - ControllerDigitalOutputs.8 to .23

Also, refer to the Read First Safety Requirements and Instruction Assembly. In this manual assembly refer to the “Robot General-Purpose I/O Signal Assignment” section of the YRC1000 Instruction manual (178642-1CD). The Controller universal inputs and outputs can be accessed with the ControllerDigitalInput and the ControllerDigitalOutput tags, which are aliased to internal tags. Refer to Fig. 2-24.

<table>
<thead>
<tr>
<th>NOTICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Controller universal input and output numbers are offset by 1. For example, universal output #1 is controlled by ControllerDigitalOutputs[0].</td>
</tr>
</tbody>
</table>
3 MLX300 Software

The package includes a base RSLogix5000 ladder with 43 AOIs that are specific to the Manipulator configuration and motion control. A complete set of HMI screens were developed for the Pro-face Pendant, the AB MobileView Pendant and the AB PanelViews. The HMI software can be operate a basic Manipulator, or it can be customized for a complex application. Technical tutorials on how to use the MLX HMI are available on the Motoman website.

3.1 PLC Ladder Software

The MLX300 comes with software for both the Rockwell ControlLogix and CompactLogix PLC. The “x_x_x” in the file names below is the version number.

- MLX300_CompactLogix_vx_x_x.ACD
- MLX300_ControlLogix_vx_x_x.ACD

Use Rockwell Studio 5000 Logix Designer, version 24, or newer to download the appropriate ladder to the PLC. Refer to the MLX300 Software and Operations manual for more details on how to use the AOIs to configure and move the Manipulator.
3.2 Rockwell HMI and Pendant Software

CAUTION

- End user and integrator must do appropriate testing when deploying .APA files to different devices.
- This responsibility lies entirely on the end user and integrator.

The end user and integrator must use caution and do appropriate testing when deploying .APA files to different devices. Test each device to make sure the appropriate access is granted, paying special attention to match the criteria mentioned in this section.

FactoryTalk View project files (.APA) are provided with every MLX300 system. Two sets of files were created to help the integrator enforce “single point of control” requirements. This will be explained after the file names.

- MLX300_Pendant_MobileView_vx_x_x.APA
  - As the name suggested, software should be installed in the MobileView. This Pendant will allow access to all of the jogging and teaching features available. There will be no limitation to screen access when the appropriate user login is used.

- MLX300_HMI_PCorPanelView_vx_x_x.APA
  - This software must be installed in any remote stations, such as PanelView HMIs, or computer. The MLX300 screens in this HMI software will be disable and invisible when a Pendant is connected. The intent here is enforce “single point of control”, by allowing only one interface to jog the Manipulator. To access the MLX300 screens in this software, the Programming Pendant must be disconnected, the MLX300 Pendant must be disconnected, and the MLX300 Pendant bypass plug must be installed. The Pendant bypass plug provides dual channel signals to the Controllers machine safety inputs. It is critical that only this software is used in PanelView stations!

NOTICE

- It is up to the integrator or end user to perform a risk assessment, before placing the system into production.
- The default password for the expert login is no password.

Use Factory Talk View Studio - Machine Edition, version 7.0 or higher to download the screens to the HMI. The default resolution of the MLX300 HMI Project is 640x480. This should be changed to match the desired resolution for the MobileView (1280x800). This can be done under the “Project Settings” in Factory Talk View Studio, after making the change all screens will automatically scale to the new size.
3.2.1 MobileView Settings

A few other settings in the MobileView should be changed. The project file that is loaded into the MobileView includes momentary push button functionality. When the buttons are pressed for a long time, the default interaction is for this to act as a “right mouse click.” It is desirable to change this functionality.

These settings are described in the Rockwell's manual and are also listed here to draw attention. Any documentation in the Rockwell manual or documentation should override the procedure or screenshots that follow.

1. Tap the “Touch” tab from the MobileView 2711T terminal desktop.
2. Select the Touch action “Press and hold” by tapping and then press the {Settings...} button.

Fig. 3-1: Touch Tab

3. Deselect the “Enable press and hold for right-clicking” box and then press the {OK} button.

Fig. 3-2: Press and Hold Settings Screen
4. Tap the {Apply} button on the “Touch” tab.

5. Enable EWF to save the settings by referring to page 35 of the Rockwell manual for details on how to manipulate this feature.

### 3.3 Pro-face HMI and Pendant Software

The Pro-face HMI screens are almost identical to the Rockwell MobileView screens. One difference is the jog buttons are dedicated to the buttons on the sides of the Pendant, instead of on the touch screen.

- **MLX300_Pendant_Proface_vx_x_x**
  - This software is for the Pro-face Pendant, Motoman part number 182097-1

- **MLX300_HMI_Proface_vx_x_x**
  - This software is for the Pro-face HMI, which could be any SP5000 series display.

Use Pro-face GP-Pro EX, version 4.06.300 or higher to download the software to the Pendant.

**NOTICE**

The default password for the expert login is “EXPERT1”. The Pro-face HMI password is different than the Rockwell HMI password, because it requires a number.
4 Collision Detection Setup

The collision detection feature is setup with default values at Yaskawa before shipment. It is possible to make the settings more sensitive for the actual application. Once the production cycle is operating, the programmer can observe the maximum monitored torque values for each axis, and enter new detection levels.

### 4.1 Summary of Operations to Change Collision Detection

The collision detection settings can be viewed and adjusted only with the Programming Pendant. Follow the steps below to monitor and make adjustments.

1. With the power off, connect the Programming Pendant, and turn power on.
2. Disconnect the Pendant communication using procedures in Appendix A.1 "Method to Disconnect Programming Pendant with Software".
3. With the Pendant key-switch set to REMOTE, and the MLX300 key-switch set to AUTO mode, cycle the production sequence for 30 minutes to warm-up the Manipulator. The MLX300 jobs cannot be started with the MLX300 Pendant, since it is not connected. The jobs can be started with an HMI display or computer. (Refer to section 2.1 “MLX300 Hardware Configurations” on page 2-1)
4. Connect the Programming Pendant communication with the procedure in Appendix A.2 "Method to Reconnect Programming Pendant with Software".
5. Switch the Programming Pendant key-switch to TEACH mode.
6. Referring to section 4.2 “Login as Manager” and section 4.3 “Collision Detection Setting - AUTO Mode”, clear the detection level of all axes.
7. Disconnect the Programming Pendant communication.
8. With the Programming Pendant key-switch in REMOTE, and the MLX300 key-switch in AUTO mode, cycle the production sequence for 15 minutes, or enough time to get a good maximum disturbance feedback.
9. Connect the Programming Pendant communication.
10. Switch the Programming Pendant key-switch to TEACH mode.
11. Referring to section 4.2 through section 4.4, enter the new detection levels of all axes. Use condition file #8 for AUTO mode settings and #9 for MANUAL mode settings.

---

**NOTICE**

Higher collision detection settings are used internally when the Manipulator is cold after a power-up. This will compensate for the changes in grease viscosity as the Manipulator warms up. The grease needs to be warmed up to be able to get valid readings. It is important to cycle the Manipulator for over 30 minutes, before setting up collision detection. During the warm-up period, collision detection alarms will not work until the detection levels increase above the setting plus the internal offset.
Many operations on the Programming Pendant require the management password. On the Pendant Main Menu, press {SYSTEM INFO}, and select {SECURITY}. Choose “MANAGEMENT MODE” in the list and enter the correct password.

Fig. 4-1: Logging in as Manager
4.3 Collision Detection Setting - AUTO Mode

To access the Collision Detection screens, using the Programming Pendant press (ROBOT) on the Main Menu, and select (SHOCK SENS LEVEL). It is very important to change the condition file number to 8, by pressing the [PAGE] button on the Pendant. The top of the screen displays “COND. NO.: 8 (STANDARD)".

**NOTICE**

For MLX300, only condition file 8 (STANDARD) is used during AUTO mode. Condition files 1-7 are not used with the MLX300. The condition file 9 is used for MANUAL mode jogging.

**Fig. 4-2: Setting Collision Detection**

It is good practice to clear the max disturbance values after the 30 minute warm-up period, and before monitoring the values for adjusting the detection levels. To reset the MAX DISTURB values back to zero, press (DATA), and select (CLEAR MAX VALUE).

**Fig. 4-3: Clearing Maximum Disturbance Values**
Run the production sequence for a multiple of cycles to get good feedback for the “MAX DISTURB” column. The max disturbance is the monitored max torque for each axis. The “DETECT LEVEL” settings for each axis can be adjusted to make it more sensitive. It is recommended to make the detection settings 15 higher than the maximum disturbance values monitored.

**NOTICE**

The DETECT LEVEL range is 0-300. 100 is the factory default.

**Fig. 4-4: Setting Detection Level**

*Set Detection Level = Max. Disturb + 15*
4.4 Collision Detection Setting - TEACH Mode

Press the [PAGE] button on the Programming Pendant to advance the collision detection screen to condition file 9. This setting is only for TEACH or MANUAL mode. Jog the Manipulator around at the highest speed and move all axes. It is recommended to make the detection setting to 15 higher than the maximum disturbance value monitored.

Fig. 4-5: Setting Collision Detection Setting in TEACH mode
5 Soft Limits Adjustments

To change the soft limits of an axis use the Programming Pendant.

1. With the power off, plug in the Pendant and turn the power on.
2. Turn the Pendant key switch to TEACH mode.
3. Press (System Info) > (Security) and log into MANAGEMENT mode.
4. Press (Robot) > (Soft Limit Setting)
5. At the top of the screen, press (Display) > (Coordinate Change) to display the limits in degrees.

Fig. 5-1: Axis Soft Limits
6 Brake Release

The Manipulator brakes can be released one at a time using the Programming Pendant. To access the Brake Release screen, press [ROBOT] and select [MANUAL BRAKE RELEASE]. Answer (YES) to the “Manual Brake Release. Operate?” prompt.

Fig. 6-1: Releasing Brake

Highlight the axis label which corresponds to the axis to release the brakes on. Squeeze the Pendant enabling switch and press the [INTERLOCK]+[SELECT] buttons at the same time. The brakes for that axis will release and the axis might drop due to gravity.
Before shipping a Manipulator to a different location, place the Manipulator in its standard shipping position. Reference the Manipulator Instructions for details concerning position and shipping brackets.

Use the Programming Pendant to move the Manipulator into the shipping position.

1. With the power off, plug in the Pendant and turn power on.
2. Turn the Pendant key switch to TEACH mode.
3. Press (JOB) > (SELECT JOB), and select “SHIP” job.

![Fig. 7-1: Selecting “SHIPPING_POSITION” Job]

4. Move the cursor to the line with the “MOVJ” command.

![Fig. 7-2: Selecting “MOVJ” in “SHIP” Job]
5. Press the [SLOW] button on the Pendant so the Manipulator does not move too fast.

*Fig. 7-3: Programming Pendant Buttons*

6. Press the [SERVO ON READY] button, and squeeze the enabling switch on the back of the Pendant to turn servo power on.

7. Press and hold the [FWD] button to move the Manipulator to the shipping position.

8. Install shipping brackets per the Manipulator instructions, if required.
8 MLX300 PLC Software Version Upgrade Procedure

Follow the steps below when installing a new MLX300 PLC software version. By following the steps below all the application data will be save and restored.

8.1 Export Manipulator Application Data from RSLogix Ladder

1. Using the MLX300 Application Backup Software, export the teach points, interference zones, tools, and user frames. The MLX300 Application Backup manual can be used as a reference. Press the {?] on the main screen to bring up the manual.

   a) With the computer connected to the Ethernet switch, double click on the MLx300AppBackup.exe file.

2. On the MLx300AppBackup screen, select the Manipulator number the PLC processor slot number and the IP address of the PLC Ethernet card.

3. Press {...} in the Export Data section of the MLx300AppBackup screen to select the desired storage data directory location.

NOTICE

Make sure the following files are in the same directory:
- MLx300AppBackup.exe
- MfgControl.AdvancedHMI.Drivers.dll
- 181925-1CD.pdf
8.2 Export non-MLX Tasks from the RSLogix Ladder

Export all PLC ladder tasks to the new PLC ladder if the tasks are to be operational after a software upgrade.

1. In the RSLogix Controller Organizer, right-click on the task, and select {Export program}.
2. Confirm the file name and storage location, and press {Export}.

8.3 Download New Version of MLX300 PLC Software

Download new version of MLX300_CompactLogix_vx_x_x.ACD or MLX300_ControlLogix_vx_x_x.ACD ladder to the PLC.

8.4 Setup I/O Configuration in RSLogix Ladder

Insert devices into the I/O Configuration of the ladder and copy board software revision numbers from the old ladder.

8.5 Import Tasks into the New RSLogix Ladder

1. In the RSLogix Controller Organizer, right click on {Unscheduled Programs/ Phases}, and select {Import Program}.
2. Browse to the desired file and press {OK} by referencing section 8.2 “Export non-MLX Tasks from the RSLogix Ladder”.
3. Resolve alarms after importing tasks. For instance, if a modified AOI has different data types or new entries, the old AOI needs to be deleted and replaced with the new AOI. Re-establish tags by right-clicking on the tag, and selecting {New}.

**Actual File Name** | **What the File Is**
--- | ---
MLx300AppBackup Teach Points.txt | Teach Points of each Job
MLx300AppBackup Tools.txt | Tools
MLx300AppBackup User Frames.txt | User Frames
MLx300AppBackup Interference Zones.txt | Interference Zones

* There is an option to transfer one file at a time.
8.6 Import the Manipulator Application Data into the PLC Ladder

Using MLx300AppBackup software, re-load the Job Teach Points, Interference Zones, Tools and User Frames by referencing section 8.1 “Export Manipulator Application Data from RSLogix Ladder”.

1. Place the PLC in program mode.

2. In the Import Data area of the MLx300AppBackup main screen, press {...} to browse to a directory location where the data was stored.

3. Highlight each file to be imported, by pressing [Cntrl]+[Left Mouse Button], and press [Open]. Observe all data in section 8.1 “Export Manipulator Application Data from RSLogix Ladder” is imported into the new RSLogix ladder.

4. Press {Start Import of Listed Files}.

5. After files are imported, a confirmation message will be displayed. Press {OK} to continue.
9  Motosim EG-VRC Virtual Controller Setup Procedure

9.1  Pre-requisites

- MotoSim EG-VRC 2015 License or newer
  - MotoSim EG-VRC needs a valid License dongle
- Manipulator Controller settings
  - Network Ethernet Server - Must be active and have correct IP settings
  - Ethernet Server - Must be active
- Manipulator parameters (Already set before shipment)
  - S1D199 = 1 - Using absolute feedback data
  - Pseudo Input 87015 = ON CMD REMOTE SEL

**NOTICE**

If the Programming Pendant is connected, the key-switch must be set to REMOTE, and the Programming Pendants communication to the Controller must be disconnected. Refer to Appendix A.

9.2  Debug Mode for Simulation

Activate the Debug mode for simulation (Controller: rotary switch = 6) and power-on the system. It is also possible to use the Online function without debug mode. This will mean both physical Manipulator and the Manipulator model in MotoSim EG-VRC will move.

*Fig. 9-1: Debug Mode for Simulation Setting*
9.3 Create a MotoSim EG-VRC Project

1. Click on MotoSimEG-VRC Icon to Launch Program
   
   *Fig. 9-2: MotoSim Icon*

2. Select [New] to Create the New Program
   
   *Fig. 9-3: Creating a New Project*

3. Assign a new name to the project and select [Open]
   
   *Fig. 9-4: Naming Project*
9.3 Create a MotoSim EG-VRC Project

4. Add a New Controller
   a) Select Controller Tab
   b) Click on New
   c) Select VRC Controller (Network)
   d) Select OK

Fig. 9-5: Adding a New Controller

5. Enter Controller Model and IP Address
   a) Select Controller Kind from the pull-down menu.
   b) Enter Controller Name and Ethernet IP Address and click OK.

Fig. 9-6: Selecting Controller Kind, Name and IP Address
6. Select **System Version** and click **OK**

**NOTICE**

The system version that will actually be used is the version of software loaded on the Controller.

Fig. 9-7: **System Version Select**

7. Robot Setup is complete, Click **OK**

Fig. 9-8: **Setup Complete**
9.3 Create a MotoSim EG-VRC Project

8. Close Virtual Pendant, it is not used for the MLX300

*Fig. 9-9: Virtual Pendant*
9.4 Starting Online Function

1. Select **Online Function**
2. Select **Network**

*Fig. 9-10: Selecting Network*

3. Click on the Controller Name in the list
4. Select **Connect**, Controller connects.

*Fig. 9-11: Connecting Controller*

5. MLX300 HMI or PLC ladder commands makes the Manipulator move.

*Fig. 9-12: Controller Connected*
9.5 Option to use Motosim with the Manipulator Disconnected

1. Place the Controller in Maintenance Mode by pressing and holding the [Main Menu] Programming Pendant key and turning the Controller on.

2. From the Main Menu select {SYSTEM} then {SECURITY}.

3. Login to SAFETY MODE.
9.5 Option to use Motosim with the Manipulator Disconnected

4. Select {SYSTEM}, {SETUP} then “CONTROL GROUP”.

5. Select DETAIL from the “CONTROL GROUP” Menu.

6. Move Cursor to “OT”, press the [Select] key, select “NOT CONNECT” and press [Enter].
7. On “Modify? CONNECT” and “Initialize related files?” screens select {YES}.

8. The Manipulator is now disconnected. Reboot the Controller.
Appendix A

A.1 Method to Disconnect Programming Pendant with Software

During System integration, it might be desirable to jog the Manipulator from a computer before all the hardware has been installed. However, there will be an issue turning on the servo power, since the computer does not have an enabling switch. There is a method available to disable the Controller communication to the Pendant and use the Pendants enabling switch. Follow the steps below to disable the Pendant communication. Once it is disabled, the operator can grasp the Pendant enabling switch and turn on servo power with a computer.

1. Press and hold the {Simple Menu} button until the Disconnect pop-up screen appears.
2. Press {Disconnect}, {Yes}, and {OK}.

**NOTICE**
The following screen shots are for a DX200, the YRC1000 screen shots are similar.
A.2 Method to Reconnect Programming Pendant with Software

1. Press the {Connect to DX200} button.

NOTICE

The following screen shots is for a DX200, the YRC1000 screen shot is similar.
Appendix B

B.1 Glossary

3D Graphic Display Function
The 3D Graphic Display Function (this will be called 3D Display Function) is that, a 3D model of the Manipulator is displayed on the Programming Pendant window, and the current value of the Manipulator can be confirmed. By using the multi-window function, the job’s teaching position displayed in the job content can also be confirmed on the 3D display window. When the functional safety function is valid, the functional safety range can also be displayed.

Absolute Data (ABSO Data)
Absolute Data (ABSO Data) is a correction factor for data that establishes an indicated value of zero when the Manipulator is at the predetermined Home (calibration position).

AC Bit
AOI output bit that turns on when motion begins executing and off when motion completes.

Accuracy
Accuracy is the measurement of the deviation between the command characteristic and the attained characteristic (R15.05-2), or the precision with which a computed or calculated Manipulator position can be attained. Accuracy is normally worse than the arm’s repeatability. Accuracy is not constant over the workspace, due to the effect of link kinematics.

Active Compliant Robot
An active compliant Manipulator is one in which motion modification during the performance of a task is initiated by the control system. The induced motion modification is slight, but sufficient to facilitate the completion of a desired task.

Actual Position
The position or location of the tool control point. Note that this will not be exactly the same as the demand position, due to a multitude of unsensed errors, such as link deflection, transmission irregularity, tolerances in link lengths, etc.

Actuator
A power mechanism used to effect motion, or maintain position of the Manipulator (for example, a motor which converts electrical energy to effect motion of the Manipulator) (R15.07). The actuator responds to a signal received from the control system.

Add on Instruction (AOI)
An Add On Instruction is a custom function block that can be inserted into a Rockwell PLC ladder.
Algorithms
Self-contained step-by-step set of instructions to perform

ANSI/RIA R15.06-2012 American National Standard for Industrial Robots and Robot Systems
This standard provides guidelines for the manufacture and integration of Industrial Robots and Robot Systems with emphasis on their safe use, the importance of risk assessment and establishing personnel safety. This standard is a national adoption of the International Standards ISO 10218-1 and ISO 10218-2 for Industrial Robots and Robot Systems, and offers a global safety standard for the manufacture and integration of such systems.

APA Files
See Factory Talk View

ArcWorld
Robotic welding systems delivering flexible integrated robotics into the welding processes. ArcWorlds can be configured with multiple Manipulators, a heavy-duty Positioner or servo-controlled external axes for coordinated motion.

Automatic Mode
See "Play Mode".

Axis
A direction used to specify the Manipulator motion in a linear or rotary mode. (ISO 8373)

Axis Backlash
Play between drive train gears

Axis Interference
The Axis Interference Area is a function that judges the current position of each axis and outputs a signal based on whether the current position is within a predefined range.

Base
The stable platform to which an industrial robotic arm is attached.

Base Coordinate System
The Base Coordinate System (sometimes referred to as World Coordinate System) defines a common reference point for a cell or application. This is useful when using multiple Manipulators or devices as positions defined in Base Coordinates will be the same for all Manipulators and devices.

Burn-in
Burn-In is a Manipulator testing procedure where all components of the Manipulator are operated continuously for an extended period of time. This is done to test movement and movement programming of the Manipulator at early stages to avoid malfunctions after deployment.

Bypass Plug
Provides dual channel signals to the Controllers machine safety inputs
Computer Aided Design (CAD)
Computer Aided Design (CAD). Computer graphic applications designed to allow engineering of objects (or parts), which are to be manufactured. A computer is used as a tool to design schematics and produce blueprints, which enable the accurate production of the object. The CAD system enables the three dimensional drawings of basic figures, exact sizing and placement of components, making lines of specified length, width, or angle, as well as satisfying varying geometric shapes. This system also allows the designer to test a simulated part under different stresses, loads, etc.

Cartesian Coordinates
Cartesian Coordinates is a type of coordinate system that specifies the location of a point in two dimensional space by a pair of numerical numbers, which further specify the distance to fixed axes that are perpendicular to each other. In simple terms, an XY graph represents a two dimensional Cartesian Coordinate System. When a point is specified in a three dimensional space (XYZ graph), it constitutes a three dimensional Cartesian coordinate system. A Manipulator’s TCP position is specified in a Cartesian Coordinate.

Cartesian Manipulator
A Cartesian Manipulator is a Manipulator arm with prismatic joints, which allows movement along one or more of the three- axes in the X, Y, Z coordinate system.

Cartesian Topology
A topology, which uses prismatic joints throughout, normally arranged to be perpendicular to each other.

Cartesian-coordinate Robot
A Cartesian-coordinate Robot is a Manipulator whose Manipulator-arm degrees of freedom are defined by Cartesian Coordinates. This describes motions that are east-west, north-south and up-down, as well as rotary motions to change orientation.

Category 3 (Cat3)
Category 3 (Cat 3) means that the safety related parts of the control system will be designed so that:
• Single faults will not prevent the safety function from working correctly.
• Single faults will be detected at or before the next demand of the safety function.
• When a single fault does occur, a safe state shall be maintained until the detected fault is corrected.
• All reasonably foreseeable faults are detected.

Caution
Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

Appendix B
Centrifugal Force
When a body rotates about an axis other than one at it's center of mass, it exerts an outward radial force called centrifugal force upon the axis, which restrains it from moving in a straight tangential line. To offset this force, the Manipulator must exert an opposing torque at the joint of rotation.

Circular Motion Type
A calculated path that the Manipulator executes, and is circular in shape.

Clamp
An end-effector which serves as a pneumatic hand that controls the grasping and releasing of an object. Tactile, and feed-back force sensors are used to manage the applied force to the object by the clamp. See "End-effector".

Clamping
The maximum permissible force acting on a body region, resulting from a Manipulator collision where the period of contact results in a plastic deformation of a person’s soft tissue.

Clamping Force
When contact can cause a body part(s) to be clamped.

Closed-loop
Control achieved by a by means of feedback information. As a Manipulator is in action, its sensors continually communicate information to the Controller, which is used to further guide the Manipulator within the given task. Many sensors are used to feed back information about the Manipulator's placement, speed, torque, applied forces, as well as the placement of a targeted moving object, etc. See "Feedback".

Command Interpreter
A module or set of modules that determines what the received command means. The command is broken down into parts (parsed) and processed.

Command Position
The endpoint position of a Manipulator motion that the Controller is trying to achieve.

Compliance
Displacement of a Manipulator in response to a force or torque. A high compliance means the Manipulator moves a good bit when it is stressed. This is called spongy or springy. Low compliance would be a stiff system when stressed.

Configuration
The arrangement of links created by a particular set of joint positions on the Manipulator. Note that there may be several configurations resulting in the same endpoint position.

Contact Sensor
A device that detects the presence of an object or measures the amount of applied force or torque applied on the object through physical contact with it. Contact sensing can be used to determine location, identity, and orientation of work pieces.
Continuous Path
Describes the process where by a Manipulator is controlled over the entire path traversed, as opposed to a point-to-point method of traversal. This is used when the trajectory of the end-effector is most important to provide a smooth movement, such as in spray painting etc. See "Point-to-Point".

Control Algorithm
A monitor used to detect trajectory deviations in which sensors detect such deviations and torque applications are computed for the actuators.

Control Command
An instruction fed to the Manipulator by means of the human-to-machine input device. See Programming Pendant. This command is received by the Controller system and is interpreted. Then, the proper instruction is fed to the Manipulator's actuators, which enable it to react to the initial command. Many times, the command must be interpreted with the use of logic units and specific algorithms. See "Input Devices" and "Instruction Cycle".

Control Device
Any piece of control hardware providing a means for human intervention in the control of a Manipulator or Manipulator system, such as an EMERGENCY STOP button, a START button, or a selector switch. (R15.06)

Control Mode
The means by which instructions are communicated to the Manipulator.

Controllability
The property of a system by which an input signal can take the system from an initial state to a desired state along a predictable path within a predetermined period of time.

Controller
An information processing device whose inputs are both the desired and measured position, velocity or other pertinent variables in a process and whose outputs are drive signals to a controlling motor or actuator. (R15.02)

Controller System
The control mechanism is usually a computer of some type, which is used to store data (both Manipulator and work environment), and store and execute programs, which operate the Manipulator. The Controller System contains the programs, data, algorithms; logic analysis, and various other processing activities, which enable it to perform. See "Robot".

Coordinate System or Frame
A Coordinate System (or Frame) defines a reference position and orientation from which a Manipulator position can be measured. All Manipulator positions are defined with reference to a Coordinate System. Yaskawa Manipulators utilize the following Coordinate Systems:
  • "Base Coordinate System"
  • "Robot Coordinate System"
  • "User Coordinate System"
  • "Cartesian Coordinates"
Central Processing Unit (CPU)
The Central Processing Unit (CPU) is the main circuit board and
processor of the Controller System.

Cubic Interference Area
This area is a rectangular parallelepiped, which is parallel to the base
coordinate, Manipulator coordinate or user coordinate. The Controller
judges whether the current position of the Manipulator’s TCP is inside or
outside this area, and outputs this status as a signal.

Cycle
A single execution of a complete set of moves and functions contained
within a Manipulator program. (R15.05-2)

Cyclic Coordinate System
A coordinate system that defines the position of any point in terms of an
angular dimension, a radial dimension and a height from a reference
plane. These three dimensions specify a point on a cylinder.

Cyclo Drive
A brand name for a speed reduction device that converts high speed low
torque to low speed high torque, usually used on the major (larger) axis.

Cylindrical Topology
A topology where the arm follows a radius of a horizontal circle, with a
prismatic joint to raise or lower the circle. Not popular in industry.

Danger
Indicates an imminently hazardous situation which, if not avoided, will
result in death or serious injury. Safety Signs identified by the signal word
DANGER should be used sparingly and only for those situations
presenting the most serious hazards.

Dead Man Switch
Deprecated term. See "Enabling Device".

Degrees of Freedom
The number of independent directions or joints of the Manipulator
(R15.07), which would allow the Manipulator to move its end effector
through the required sequence of motions. For arbitrary positioning, six
degrees of freedom are needed: three for position (left-right, forward-
backward and up-down), and three for orientation (yaw, pitch and roll).

Direct-drive
Joint actuation, including no transmission elements (i.e., the link is bolted
onto the output of the motor.)

DN Bit
AOI output bit that turns on when the Controller has acknowledged the
motion command and motion has been queued.

Downtime
A period of time, in which, a Manipulator or production line is shut down,
due to malfunction or failure. See "Uptime".
Drive
A speed (gear) reducer to convert high speed low torque to low speed high torque. See "Harmonic Drive", "Cyclo Drive" and "Rotary Vector Drive (RV)".

Drop Delivery
A method of introducing an object to the workplace by gravity. Usually, a chute or container is so placed that, when work on the part is finished, it will fall or drop into a chute or onto a conveyor with little or no transport by the Manipulator.

Dynamics
The study of motion, the forces that cause the motion and the forces due to motion. The dynamics of a Manipulator arm are very complicated as they result from the kinematic behavior of all masses within the arm's structure. The Manipulator arm kinematics are complicated in themselves.

Electromagnetic Interference (EMI)
EMI is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction.

Emergency Stop
The operation of a circuit using hardware-based components that overrides all other Manipulator controls, removes drive power from the Manipulator actuators, and causes all moving parts to stop. (R15.06)

Enable Switch
See "Enabling Device".

Enabling Device
A manually operated device which when continuously activated, permits motion. Releasing the device shall stop Manipulator motion and motion of associated equipment that may present a hazard. (R15.06)

Encoder
A feedback device in the Manipulator arm that provides current position (and orientation of the arm) data to the Controller. A beam of light passes through a rotating code disk that contains a precise pattern of opaque and transparent segments on its surface. Light that is transmitted through the disk strikes photo-detectors, which convert the light pattern to electrical signals. See "Feedback", "Closed-loop" and "Feedback Sensor".

Envelope
Is the range of movement available. This range is determined by the length of a Manipulator's arm and the design of its axes. Each axis contributes its own range of motion.

EN Bit
AOI output bit that turns on when the instruction is enabled.
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End-effector
An accessory device or tool, specifically designed for attachment to the Manipulator wrist or tool mounting plate to enable the Manipulator to perform its intended task. (Examples may include: gripper, spot weld gun, arc weld gun, spray point gun or any other application tools.) (R15.06)

Endpoint
The nominal commanded position that a Manipulator will attempt to achieve at the end of a path of motion. The end of the distal link.

EOAT
See "Gripper" or "End-effector".

Error
The difference between the actual response of a Manipulator and a command issued.

Expandability
Being able to add resources to the system, such as memory, larger hard drive, new I/O card, etc.

External Force Limit
The threshold limit where the Manipulator moves to or retains position, even when external forces are applied (provided that forces do not exceed limits that would cause an error).

Factory Talk View Project Files
Windows-based software files for creating Manipulator monitoring and controls

Feedback
The return of information from a Manipulator or sensor to the processor of the Manipulator to provide self-correcting control of the Manipulator. See "Feedback Control" and "Feedback Sensor".

Feedback Control
A type of system control obtained when information from a Manipulator or sensor is returned to the Controller in order to obtain a desired Manipulator effect. See "Feedback", "Closed-loop" and "Feedback Sensor".

Feedback Sensor
A mechanism through which information from sensing devices is fed back to the Manipulator's control unit. The information is utilized in the subsequent direction of the Manipulator's motion. See "Closed-loop" and "Feedback Control".

Flexibility
The ability of a Manipulator to perform a variety of different tasks.

Force Feedback
A sensing technique using electrical signals to control a Manipulator end-effector during the task of the end-effector. Information is fed from the force sensors of the end-effector to the Manipulator control unit during the particular task to enable enhanced operation of the end-effector.
See "Feedback", "Feedback Sensor" and "Force Sensor".

**Force Sensor**
A sensor capable of measuring the forces and torque exerted by a Manipulator and its wrist. Such sensors usually contain strain gages. The sensor provides information needed for force feedback. See "Force Feedback".

**Forward Kinematic Solution**
The calculation required to find the endpoint position, given the joint positions. For most Manipulator topologies this is easier than finding the inverse kinematic solution.

**Forward Kinematics**
Computational procedures which determine where the end-effector of a Manipulator is located in space. The procedures use mathematical algorithms along with joint sensors to determine its location.

**Frame**
A coordinate system used to determine a position and orientation of an object in space, as well as the Manipulator's position within its model.

**Functional Safety Unit (FSU)**
The Functional Safety Unit (FSU) is a component of the Manipulator Controller that provides programmable safety functions that enable collaborative operation of the Manipulator. As these safety functions are programmable, the FSU allows the minimization of nearby overall equipment footprint, as well as human accessible areas. The FSU consists of two parallel Central Processing Units (CPUs) run concurrently, thereby providing dual channel checking. In addition, the FSU acquires Manipulator position from its encoders independently from the motion control system of the Manipulator. Based on this feedback, the FSU monitors the Manipulator and tool's position, speed and posture.

**Gravity Loading**
The force exerted downward, due to the weight of the Manipulator arm and/or the load at the end of the arm. The force creates an error with respect to position accuracy of the end effector. A compensating force can be computed and applied bringing the arm back to the desired position.

**Gripper**
An end effector that is designed for seizing and holding (ISO 8373) and "grips" or grabs an object. It is attached to the last link of the arm. It may hold an object using several different methods, such as: applying pressure between its "fingers", or may use magnetization or vacuum to hold the object, etc. See "End-effector".

**Hand**
A clamp or gripper used as an end-effector to grasp objects. See "End-effector", and "Gripper".
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**Hardstop**
Physical block that defines the movement stop positions

**Harmonic Drive**
Compact lightweight speed reducer that converts high speed low torque to low speed high torque. Usually found on the minor (smaller) axis.

**Harness**
Usually several wires, bundled together to deliver power and/or signal communications to/from devices. For example, the Manipulator motors are connected to the Controller through a wire harness.

**Hazardous Motion**
Unintended/unexpected Manipulator motion that may cause injury.

**Headstock**
Positioner column containing the driving mechanism

**HMI**
See Human Machine Interface

**Hold**
A stopping of all movements of a Manipulator during its sequence, in which some power is maintained on the Manipulator. For example, program execution stops, however power to the servo motors remain on, if restarting is desired.

**Home Position**
A known and fixed location on the basic coordinate axis of the Manipulator where it comes to rest, or to an indicated zero position for each axis. This position is unique for each model of Manipulator. On Manipulators there are indicator marks that show the Home position for the respective axis.

**Human Machine Interface**
An interface which permits a manipulator responding to commands from a human operator

**IEC**
International Electrotechnical Commission

**Inductive Sensor**
The class of proximity sensors, which has half of a ferrite core, whose coil is part of an oscillator circuit. When a metallic object enters this field, at some point, the object will absorb enough energy from the field to cause the oscillator to stop oscillating. This signifies that an object is present in a given proximity. See "Proximity Sensor".

**Industrial Robot**
A re-programmable multi-functional Manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks (R15.06). The principle components are: one or more arms that can move in several directions, a Manipulator, and a computer Controller that gives detailed movement instructions.
INFORM
The Manipulator programming language for Yaskawa Manipulators is INFORM. INFORM language allows the Manipulator user to: instruct the Manipulator to use its basic capabilities to fulfill a defined set of expectations and also to describe to the Manipulator, through a definition of parameters and conditions, what the expectations are in some given situations or scenarios. In simple terms, the INFORM programming language allows the user to instruct the Manipulator on what to do, when to do it, where to do it and how to do it.

Input Devices
A variety of devices, which allow a human to machine interface. This allows the human to program, control, and simulate the Manipulator. Such devices include Programming Pendant, computer keyboards, a mouse, joy-sticks, push buttons, operator panel, operator pedestal etc.

Instruction
A line of programming code that causes action from the system Controller. See “Command Position”.

Instruction Cycle
The time it takes for a Controller system's cycle to decode a command or instruction before it is executed. The Instruction Cycle must be analyzed very closely by Manipulator programmers to enable speedy and proper reaction to varying commands.

Integrate
To fit together different subsystems, such as Manipulators and other automation devices, or at least different versions of subsystems in the same control shell.

Integrator
A company that provides value added services that results in creation of automation solutions by combining a Manipulator and other automation and controls equipment to create an automation solution for end users.

Intelligent Robot
A Manipulator that can be programmed to make performance choices contingent on sensory inputs with little or no help from human intervention. See “Robot”.

Interference Area
Interference Area is a function that prevents interference between multiple Manipulators or the Manipulator and peripheral device. The areas can be set up to 64 areas. Three types of methods to use each interference area are as follows: Cubic Interference, Outside of Cubic Area and Axis Interference.

Interpolation
The method by which endpoint paths are created. In general, to specify a motion a few knot points are defined before all the intermediate positions between them are calculated by mathematical interpolation. The interpolation algorithm used therefore has a dramatic effect of the quality of motion.

IP Bit
AOI output bit that turns on and stays on during motion processing and execution.
ISO
International Organization for Standardization

ISO 10218-1 Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots
A robot specific safety specification that addresses manufacturer requirements, functionality, required safety performance, hazards, protective measures and documentation for the robot itself.

ISO 10218-2 Robots and robotic devices — Safety requirements for industrial robots — Part 2: Robot systems and integration
A companion document to ISO 10218-1. This safety specification provides guidance to both end users and robot integrators as it pertains to the safe design, installation and commissioning of robot systems, as well as recommended procedures, safeguarding and information required for use.

ISO TS 15066(ANSI RIA 15.606): Robots and robotic devices - Collaborative robots
Provides detailed guidance not found in ISO 10218 parts 1 or 2 for the safe use of industrial robots operating collaboratively.

Jacobian matrix
The Jacobian matrix relates the rates of change of joint values with the rates of change of endpoint co-ordinates. Essentially it is a set of algorithm calculations that are processed to control the positioning of a Manipulator.

JOB
JOB is the name for a Manipulator program created using INFORM programming language. Typically, a JOB consists of instructions that tell the Controller what to do and data that the program uses when it is running.

Joint
A part of the Manipulator system, which allows a rotation and/or translational degree of freedom of a link of end-effector.

Joint Interpolated Motion
A method of coordinating the movement of the joints, such that all joints arrive at the desired location simultaneously. This method of servo control produces a predictable path regardless of speed and results in the fastest pick and place cycle time for a particular move.

Joint Motion Type
Also known as Point-to-Point Motion, Joint Motion Type is a method of path interpolation that commands the movement of the Manipulator by moving each joint directly to the commanded position so that all axis arrive to the position at the same time. Although the path is predictable, it will not be linear.
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Joint Space
a. Joint Space (or Joint Coordinates) is just a method of defining the position of the Manipulator in terms of the value of each axis instead of as a TCP position. For example, the Home Position of a Manipulator is often defined in Joint Space as each axis being at 0 degrees.
b. The set of joint positions.

Joints
The parts of the Manipulator arm which actually bend or move.

Kinematics
The relationship between the motion of the endpoint of a Manipulator and the motion of the joints. For a Cartesian Manipulator this is a set of simple linear functions (linear tracks that may be arranged in X, Y, Z directions), for a revolute topology (joints that rotate) however, the kinematics are much more complicated involving complicated combinations of trigonometry functions. The kinematics of an arm is normally split into forward and inverse solutions.

Laser
Acronym for Light Amplification by Stimulated Emission of Radiation. A device that produces a coherent monochromatic beam of light which is extremely narrow and focused but still within the visible light spectrum. This is commonly used as a non-contact sensor for Manipulators. Robotic applications include: distance finding, identifying accurate locations, surface mapping, bar code scanning, cutting, welding etc.

Linear Interpolated Motion
Is a method of path interpolation that commands the movement of the Manipulator by moving each joint in a coordinated motion so that all axis arrive to the position at the same time. The path of the Tool Control Point (TCP) is predictable and will be linear.

Linear Motion Type
Is a method of path interpolation that commands the movement of the Manipulator by moving each joint in a coordinated motion so that all axis arrive to the position at the same time. The path of the Tool Control Point (TCP) is predictable and will be linear.

Link
A rigid part of a Manipulator, which connects adjacent joints.

Load Cycle Time
A manufacturing or assembly line process term, which describes the complete time to unload the last work piece and load the next one.
Magnetic Detectors
Manipulator sensors that can sense the presence of ferromagnetic material. Solid-state detectors with appropriate amplification and processing can locate a metal object to a high degree of precision. See "Sensor".

Manipulator
A machine or robotic mechanism of which usually consists of a series of segments (jointed or sliding relative to one another) for the purpose of grasping and/or moving objects (pieces or tools), usually in several degrees of freedom. The control of the Manipulator may be by an operator, a programmable electronic Controller or any logic system (for example cam device, wired, etc.) (ISO 8373)
See "Wrist" and "End-effector"

Manual Mode
See "Teach Mode".

Material Handling
The process by which an industrial robotic arm transfers materials from one place to another.

Mirror Shift Function
With the Mirror Shift Function, a job is converted to the job in which the path is symmetrical to that of the original job. This conversion can be performed for the specified coordinate among the X-Y, X-Z or Y-Z coordinate of the Manipulator coordinates and the user coordinates. The Mirror Shift Function is classified into the following three: the Pulse Mirror Shift Function, the Manipulator Coordinates Mirror Shift Function and the User Coordinates Mirror Shift Function.

MLX300 Software
Enables the user to replace the traditional YRC1000 and DX200 Controller programming language with a PLC-based ladder programming.

Mode Switch
As per safety standards, an industrial Manipulator has three distinct modes of operation. These are TEACH (also called Manual) and PLAY (also called Automatic) and REMOTE. Switching between these modes is performed using a key switch on the Programming Pendant and is called Mode Switch.

Modularity
The property of flexibility built into a Manipulator and control system by assembling separate units, which can be easily joined to or arranged with other parts or units.

Module
Self-contained component of a package. This component may contain sub-components known as sub-modules.

Motomount
Yaskawa proprietary mounting block allowing for limited play on multiple axis
Appendix B

Motion Axis
The line defining the axis of motion either linear or rotary segment of a Manipulator.

Motor
See "Servo Motor".

Muting
While testing a Manipulator program, the deactivation of any presence sensing safeguarding devices during the full Manipulator cycle or a portion of the cycle.

Notice
NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to "NOTICE", the word "CAUTION" without the safety alert symbol may be used to indicate a message not related to personal injury.

Off-line Programming
A programming method where the task program is defined on devices or computers separate from the Manipulator for later input of programming information to the Manipulator. (ISO 8373)b. A means of programming a Manipulator while the Manipulator is functioning. This becomes important in manufacturing and assembly line production due to keeping productivity high while the Manipulator is being programmed for other tasks.

Operator
The person designated to start, monitor and stop the intended productive operation of a Manipulator system. An operator may also interface with a Manipulator for productive purposes. (R15.06)

Optical Encoder
A detection sensor, which measures linear or rotary motion by detecting the movement of markings past a fixed beam of light. This can be used to count revolutions, identify parts, etc.

Optical Proximity Sensors
Manipulator sensors which measure visible or invisible light reflected from an object to determine distance. Lasers are used for greater accuracy.

Orientation
The angle formed by the major axis of an object relative to a reference axis. It must be defined relative to a three dimensional coordinate system. Angular position of an object with respect to the Manipulator's reference system. See "Roll", "Pitch" and "Yaw".
Palletizing
The process of stacking packages (i.e., boxes, bags, containers, etc.) in an organized fashion on a pallet.

PAM Function – Position Adjustment by Manual
Position Adjustment by Manual allows position adjustment by simple operations while observing the motion of the Manipulator, and without stopping the Manipulator. Positions can be adjusted in both teach mode and play mode.

Parallel Shift Function
Parallel Shift refers to the shifting of an object from a fixed position in such a way that all points within the object move an equal distance. In the model for Parallel Shift shown in the following, the shift value can be defined as the distance L (three dimensional coordinate displacement). The Parallel Shift Function is relevant to the actual operation of the Manipulator because it can be used to reduce the amount of work involved in teaching by shifting a taught path (or position). In the example in the figure below, the taught position A is shifted in increments of the distance L (this is actually a three dimensional XYZ displacement that can be recognized by the Manipulator).

Path
The continuous locus of positions (or points in three dimensional space) traversed by the tool center point and described in a specified coordinate system. (R15.05-2)

Payload - Maximum
The maximum mass that the Manipulator can manipulate at a specified speed, acceleration/deceleration, center of gravity location (offset), and repeatability under continuous operation over a specified working space. Maximum payload is specified in kilograms. (R15.05-2)

PC Bit
AOI output bit that turns on when motion execution is complete.

Pendant [Programming Pendant]
See "Programming Pendant"

Pendant Teaching
The mapping and recording of the position and orientation of a Manipulator and/or Manipulator system as the Manipulator is manually moved in increments from an initial state along a path to a final goal state. The position and orientation of each critical point (joints, Manipulator base, etc.) is recorded and stored in a database for each taught position the Manipulator passes through on its path toward its final goal. The Manipulator may now repeat the path on its own by following the path stored in the database.
Performance Level d (PLd)
ISO Performance Level (PL) “d” means that the average probability of dangerous failure per hour of the safety related parts of the control system falls within $= 10^{-7}$ to $< 10^{-6}$. Additionally, other factors such as proper installation, maintenance and protection against environmental factors also apply. This is the minimum performance level specified in ISO 10218-2 section 5.2.2, unless a risk assessment would allow a lower value to be used.

Performance Level e (PLe)
ISO Performance Level (PL) “e” means that the average probability of dangerous failure per hour of the safety related parts of the control system falls within $= 10^{-8}$ to $< 10^{-7}$. Additionally, other factors such as proper installation, maintenance and protection against environmental factors also apply.

Pick and Place Cycle
The amount of time it takes for a Manipulator to pick up an object and place it in a desired location, then return to its rest position. This includes time during the acceleration and deceleration phases of a particular task. The Manipulator movement is controlled from one point location in space to another in a Point-to-Point (PTP) motion system. Each point is programmed into the Manipulator's control memory and then played back during the work cycle.

Pick-and-Place Task
A repetitive part transfer task composed of a picking action followed by a placing action.

Pinch Points
A pinch point is any point at which it is possible for a person or part of a person's body to be caught between moving parts of a machine, or between the moving and stationary parts of a machine, or between material and any part of the machine. A pinch point does not have to cause injury to a limb or body part, although it might cause injury – it only has to trap or pinch the person to prevent them from escaping or removing the trapped part from the pinch point.

Pitch
Rotation of the end-effector in a vertical plane around the end of the Manipulator arm. See and "Yaw".

Pitch Line
Ideal line of the gear

Play Mode
After a Manipulator is programmed in Teach Mode, the Controller can be switched to Play Mode to execute the Manipulator program. In Play Mode, the Manipulator program is played back. This is the mode in which Manipulators are used in production.
Playback Operation
Playback is the operation by which the taught job is played back. This function is used to decide where to resume the playback on the start operation after suspending the playback and moving the cursor or selecting other jobs. 0: Starts operation where the cursor is located in the job displayed at the moment. 1: The playback continuation window appears. Select “YES” and the playback resumes where the cursor has been located when the playback suspended. If “NO” is selected, the playback resumes where the cursor is located in the job displayed at the moment. Modes Switch on the Programming Pendant: PLAY – job is started up by [START] on the Programming Pendant and REMOTE job is started by a peripheral device (external start input).

PLC
See Programmable Logic Controller

Point-to-Point
Manipulator motion in which a limited number of points along a projected path of motion is specified. The Manipulator moves from point to point rather than a continuous smooth path.

Pose
Alternative term for Manipulator configuration, which describes the linear and angular position. The linear position includes the azimuth, elevation and range of the object. The angular position includes the roll, pitch and yaw of the object. See "Roll", "Pitch" and "Yaw".

Position
The definition of an object's location in 3D space, usually defined by a 3D coordinate system using X, Y and Z coordinates.

Position Level
The position level is the degree of approximation of the Manipulator to a taught position. The position level can be added to move instructions MOVJ (joint interpolation) and MOVL (linear interpolation). If the position level is not set, the precision depends on the operation speed. Setting an appropriate level moves the Manipulator in a path suitable to circumferential conditions and the workpiece.

Position Variables
Position Variables are used in a Manipulator program (JOB) to define a location in 3D space, usually defined by a 3D coordinate system using X, Y and Z coordinates. As it is a variable, the value can change depending on conditions or on information passed to the JOB.

Positioner
Complete device used to position parts for welding

Presence-sensing Safeguarding Device
A device designed, constructed and installed to create a sensing field to detect an intrusion into such field by people, Manipulators or objects. See "Sensor".
Programmable Logical Controller (PLC)
A solid-state control system, which has a user programmable memory for storage of instructions to implement specific functions such as: I/O control logic, timing, counting arithmetic and data manipulation. A PLC consists of a central processor, input/output interface, memory and programming device, which typically uses relay equivalent symbols. The PLC is purposely designed as an industrial control system, which may perform functions equivalent to a relay panel or a wired solid-state logic control system, and may be integrated into the Manipulator control system.

Programmable Robot
A feature that allows a Manipulator to be instructed to perform a sequence of steps and then to perform this sequence in a repetitive manner. It can then be reprogrammed to perform a different sequence of steps if desired.

Programming Pendant
A Yaskawa hand-held input device, linked to the control system with which a Manipulator can be programmed or moved. (ISO 8373) This enables the human operator to stand in the most favorable position to observe, control and record the desired movements in the Manipulator's memory.

Proximity Sensor
A non-contact sensing device used to sense when objects are a short distance away, and it can determine the distance of the object. Several types include: radio frequency, magnetic bridge, ultrasonic and photoelectric. Commonly used for: high speed counting, sensing metal objects, level control, reading coding marks and limit switches. See "Inductive Sensor".

Pulse Coordinates
Yaskawa Manipulators define Manipulator joint axes position in degrees for revolute joints. Pulse is also another way to specify Manipulator joint position, and it does so in Manipulator motor encoder pulse counts.

Quality Assurance (QA)
Describes the methods, policies and procedures necessary to conduct quality assurance testing during design, manufacturing and deliver phases of creating, reprogramming, or maintaining Manipulators.

Quasi-static Clamping
A type of contact between a person and part of a Manipulator system where the body part can be clamped between the moving part of the Manipulator system & another fixed or moving part of the Manipulator cell.

Range of Motion
The full movement potential of the Manipulator.

Reach
The volume of space (envelope), which a Manipulator's end-effector can reach in at least one orientation.
Appendix B

**Real-time System**
A computer system in which the computer is required to perform its tasks within the time restraints of some process simultaneously with the system it is assisting. The computer processes system data (input) from the sensors for the purpose of monitoring and computing system control parameters (outputs) required for the correct operation of a system or process. The computer is required to do its work fast enough to keep pace with an operator interacting with it through a terminal device (such as a screen or keyboard). The operator interacting with the computer has access, retrieval and storage capability through a database management system. System access allows the operator to intervene and alter the system's operation.

**Record-playback Robot**
A Manipulator for which the critical points along desired trajectories are stored in sequence by recording the actual values of the joint-position encoders of the Manipulator as it is moved under operational control. To perform the task, these points are played back to the Manipulator's servo-system. See "Servo-system".

**Rectangular-Coordinate Robot**
A Manipulator whose Manipulator arm moves in linear motions along a set of Cartesian or rectangular axis in X, Y and Z directions. The shape of the work envelope forms a rectangular figure. See "Work Envelope".

**Reliability**
The probability or percentage of time that a device will function without failure over a specified time period or amount of usage (R15.02). Also called: the Manipulator's uptime or the Mean Time Between Failure (MTBF).

**Remanufacture**
To upgrade or modify Manipulators to the revised specifications of the manufacturer. (R15.06)

**Remote Mode**
Remote Mode is a type of Play Mode where the automatic execution of Manipulator program is initiated from an external device (not the Programming Pendant). During this mode, the use of the Programming Pendant is disabled.

**Repeatability**
A measure of how close an arm can repeatedly obtain a taught position. For instance: once a Manipulator is manually placed in a particular location and this location is resolved by the Manipulator, the repeatability specifies how accurately the Manipulator can return to that exact location. The degree of resolution within the Manipulator control system determines the repeatability. In general, an arm's repeatability can never be better than its resolution. See "Teach" and "Accuracy".

**Resolution**
The amount of Manipulator joint motion required for the position sensing to change by one count. Although the resolution of each joint feedback sensor is normally constant, the resolution of the endpoint in world coordinates is not constant for revolute arms, due to the non-linearity of the arm's kinematics.
Revolute Joint
The joints of a Manipulator, which are capable of rotary motion.

Risk Assessment
The process of evaluating the intended use of a machine or system for foreseeable hazards and then determining the level of risk involved for the tasks identified.

Risk Mitigation
A secondary step in the risk assessment process that involves reducing the level of risk for the identified tasks, by applying risk reduction measures in order to eliminate or mitigate the hazards.

Robot
A re-programmable, multi-functional Manipulator designed to move material, parts, tools or specified devices through variable programmed motions for the performance of a variety of tasks. Common elements which make up a Manipulator are: Controller, Manipulator and end-effector. See "Manipulator", "Controller" and "End-effector".

Robot Coordinate System
The Robot Coordinate System is defined in the base axis of a Manipulator, and points in the Robot Coordinate System will be relative to the base of the Manipulator. Note that by default the Base Coordinate System and Robot Coordinate System are the same.

Robot Integrator
See "Integrator".

Robot Programming Language
An interface between a human user and a Manipulator, which relates human commands to the Manipulator.

Robot Range Limit Monitoring
Monitors the Manipulator arm or its tool to be in the designated safety area.

Robot Simulation
A method for emulating and predicting the behavior and the operation of a robotic system based on the model (i.e., computer graphics) of the physical system. (R15.07)

Roll
Rotation of the Manipulator end effector in a plane perpendicular to the end of the Manipulator arm. See "Pitch" and "Yaw".

Rotary Joint
A joint which twists, swings or bends about an axis.

Rotary Vector Drive (RV)
A brand name for a speed reduction device that converts high speed low torque to low speed high torque, usually used on the major (larger) axis. See "Cyclo Drive" and "Harmonic Drive".

Rotational Motion
A joint which twists, swings or bends about an axis. An example of this is the elbow of a human arm.
Safeguard
A barrier guard, device or safety procedure designed for the protection of personnel. (R15.06)

Safety Integrity Level
Safety Integrity Level (SIL) is IEC’s method for determining the performance level of a safety system. SIL 2 corresponds to ISO Performance Level “d”, and SIL 3 corresponds to ISO Performance Level “e”. ISO 10218 allows for the use of either.

Safety Logic Circuit
The safety logic circuit monitors safety critical external devices such as the light curtains and FSU generated signals. The safety logic circuit is programmed via an intuitive user interface that is supported on the Yaskawa Programming Pendant. It enables to set up the logical operations, such as stopping the Manipulator or outputting a signal if the servos are on.

Safety Monitored Stop
Collaborative feature designed to allow safe human-Manipulator interaction. Only when Manipulator motion ceases can the human safety enter the collaborative workspace. Servos can remain energized in accordance with a category 2 stop in accordance with ISO 10218-1:2011, 5.4. A risk assessment shall be used to determine if any additional safeguarding is necessary to mitigate risks within the Manipulator system.

Second Home Position
Apart from the “home position” of the Manipulator, the second home position can be set up as a check point for absolute data. The initial value of the second home position is the home position (where all axes are at pulse 0). The second home position can be changed.

Security Mode
Levels of operator modes on the Controllers, include: Operation Mode, Edit Mode, Management Mode, Safety Mode and One Time Management mode.

Sensor
Instruments used as input devices for Manipulators, which enable it to determine aspects regarding the Manipulator’s environment, as well as the Manipulator’s own positioning. Sensors respond to physical stimuli (such as heat, light, sound, pressure, magnetism and motion), and they transmit the resulting signal or data for providing a measurement, operating a control or both. (R15.06)

Sensory Feedback
Variable data measured by sensors and relayed to the Controller in a Closed-loop System. If the Controller receives feedback that lies outside an acceptable range, then an error has occurred. The Controller sends an error signal to the Manipulator. The Manipulator makes the necessary adjustments in accordance with the error signal.
Servo Control
The process by which the control system of the Manipulator checks if the attained pose of the Manipulator corresponds to the pose specified by the motion planning with required performance and safety criteria. (ISO 8373)

Servo Motor
An electrical power mechanism used to effect motion or maintains position of the Manipulator (for example, a motor which converts electrical energy to effect motion of the Manipulator) (R15.07). The motor responds to a signal received from the control system and often incorporates an encoder to provide feedback to the control loop.

Servo Pack
An alternating, current electrical power mechanism that is controlled through logic to convert electrical supply power that is in a sine wave form to a Pulse Width Modulated (PWM) square form, delivered to the motors for motor control: speed, direction, acceleration, deceleration and braking control.

Servo-controlled Robot
The control of a Manipulator through the use of a Closed-loop Servo-system, in which the position of the Manipulator axis is measured by feedback devices and is stored in the Controller's memory. See Closed-loop System and Servo-system.

Servo-system
A system in which the Controller issues commands to the motors, the motors drive the arm, and an encoder sensor measures the motor rotary motions and signals the amount of the motion back to the Controller. This process is continued many times per second until the arm is repositioned to the point requested. See "Servo-controlled Robot"

Shock Detection Function
Shock detection is a function supported by the Controller that reduces the impact of a Manipulator collision by stopping the Manipulator without any external sensor when the tool or the Manipulator collide with a peripheral device.

SIL
See "Safety Integrity Level"

Simulation
A graphical computer program that represents the Manipulator and its environment, which emulates the Manipulator's behavior during a simulated run of the Manipulator. This is used to determine a Manipulator's behavior in certain situations, before actually commanding the Manipulator to perform such tasks. Simulation items to consider are: the 3D modeling of the environment, kinematics emulation, path-planning emulation and simulation of sensors. See "Sensor", "Forward Kinematics" and "Robot".

Singularity
A configuration where two joints of the Manipulator arm become co-axial (aligned along a common axis). In a singular configuration, smooth path following is normally impossible and the Manipulator may lose control. The term originates from the behavior of the Jacobian matrix, which becomes singular (i.e., has no inverse) in these configurations.
SLURBT
SLURBT are terms that Yaskawa Motoman uses to describe each axis of the Manipulator for convenience. The definition of each value is as follows:
S – Swing or Swivel
L – Lower Arm
U – Upper Arm
R – Rotate
B – Bend
T – Twist

Softlimit Setting Function
The Softlimit Setting Function is a function to set the axis travel limit range of the Manipulator motion in software.

Speed and Separation Monitoring
Collaborative feature that allows both the operator and Manipulator to work in proximity to one another by ensuring the Manipulator will slow down and stop before a contact situation occurs. In order for this feature to be safely implemented, functional safety and additional detection hardware must be used. A risk assessment shall be used to determine if any additional safeguarding is necessary to mitigate risks within the Manipulator system.

Spline
A smooth, continuous function used to approximate a set of functions that are uniquely defined on a set of sub-intervals. The approximating function and the set of functions being approximated intersect at a sufficient number of points to insure a high degree of accuracy in the approximation. The purpose for the smooth function is to allow a Manipulator to complete a task without jerky motion.

Spline Motion Type
A calculated path that the Manipulator executes—that may be parabolic in shape. A spline motion may also accomplish a free form curve with mixtures of circular and parabolic shapes.

Standstill Monitoring
Using the Axis Speed Monitor function will activate an emergency stop condition if a motion occurs.

Stop Position Monitoring
See "Standstill Monitoring"

Sweep Axis
Positioner axis that sweeps back and forth

Swing Arm
Casting or weldment attached headstock or tailstock column containing secondary axes

System Integrator
See "Integrator"
Tailstock
Positioner column containing the driven or idler side.

Teach
To program a Manipulator arm by manually guiding it through a series of motions and recording the position in the Controller memory for playback.

Teach Lock
While the Teach Lock is set, the mode of operation is tied to the Teach Mode and the machines cannot be played back using either [START] or external input. For safety purposes, always set the mode switch to “TEACH” before beginning to teach.

Teach Mode
A Controller mode in which a Manipulator is programmed by manually guiding it through a series of motions and recording the position in the Controller memory for playback. Industrial Manipulators that do not have an active Power and Force Limiting Function require the use of a Three Position Enabling Device in Teach Mode.

Teach Pendant
See "Programming Pendant"

Teaching Window
Teaching Window is a user interface screen on the Programming Pendant. This window contains the JOB CONTENT window and teaching is conducted within this window. The JOB CONTENT window contains the following items: line numbers, cursor, instructions, additional items, comments, etc.

Through-beam
An object detection system used within a Manipulator’s imaging sensor system. A finely focused beam of light is mounted at one end and a detector at the other. When the beam of light is broken, an object is sensed.

Time Measuring Function
Time measuring function measures the execution time for the specified section in the job or the signal output time of the specified signal.

Tool
A term used loosely to define a working apparatus mounted to the end of the Manipulator arm, such as a hand, gripper, welding torch, screw driver, etc. See “Gripper” and “End-effector”.

Tool & arm Interference
In a system with one Controller and multiple Manipulators, the Tool & Arm Interference Check Function can be used to detect possible interference to avoid collision during operation. The following three patterns can be checked:
- Arm against arm
- Arm against tool
- Tool against tool
Tool against tool
Interference is checked by using a cylinder that is slightly larger than the arm or tool. A sphere is placed on both ends of the cylinder. If the cylinder and spheres of one Manipulator have any contact with those of the other while moving, the Manipulators stop because interference was detected.

Tool Center Point (TCP)
The Tool Center Point (TCP) defines the tip of the current tool as defined relative to the tool flange. For example, for a welding Manipulator, the TCP will generally be defined at the tip of the welding gun. After defining and configuring the TCP, the Manipulator motion will be defined relative to this frame (i.e., rotation in the Rx direction would cause rotation around the X-axis and positions will be taught in this frame.

Tool Control Point
See "Tool Center Point (TCP)"

Tool Coordinates
When the tool attached to the Manipulator moves, so does its tool coordinate system in reference to a fixed coordinate system, for example, world coordinates. In general, the tool coordinates do not align with the world XYZ coordinates.

Tool Frame
A coordinate system attached to the end-effector of a Manipulator (relative to the base frame).

Total Index Time
Sum of the main axis sweep time and the secondary axis sweep times

Tooling Envelope
Volume in which the tooling can be present when rotated on its own axis

Tooling Fixture
Tooling designed for the application to be mounted on a Positioner axis where parts will be loaded and processed

Tooling Plate
Plate used to attach tooling to motomounts

Tooling Sweep
Time necessary to rotate tooling between positions

Trajectory Generation (Calculation)
The computation of motion functions that allow the movement of joints in a smooth controlled manner.

Transducer
A device that converts energy from one form to another. Generally, a device that converts an input signal into an output signal of a different form. It can also be thought of as a device which converts static signals detected in the environment (such as pressure) into an electrical signal that is sent to a Manipulator’s control system.
U

Uptime
A period of time in which a Manipulator or production line is operating or available to operate, as opposed to downtime.

User Coordinate Setting
User coordinates are defined by three points that have been taught to the Manipulator through axis operations. These three defining points are ORG, XX, and XY, as shown in the diagram below. These three points of positional data are registered in a user coordinate file. ORG is the home position, and XX is a point on the X-axis. XY is a point on the Y-axis side of the user coordinates that has been taught, and the directions of Y- and Z-axes are determined by point XY.

User Coordinate System
The User Coordinate System is any reference point that a user has defined for their application. This is often attached to an object such as a pallet and allows a user to teach points relative to this object. For example, a set of position could be taught relative to a User Coordinate System attached to a pallet and then easily transferred to a different User Coordinate System on another pallet. This allows for positions to be reused efficiently. See also, "User Coordinate Setting"

User Define Types (UDT)
UDTs can be defined in the PLC ladder to define a custom structure of PLC tags.

V

Vision Sensor
A sensor that identifies the shape, location, orientation, or dimensions of an object through visual feedback, such as a television camera.

W

Warning
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

Work Envelope
The set of all points which a Manipulator can reach without intrusion. Sometimes the shape of the work space, and the position of the Manipulator itself can restrict the work envelope.

Work Envelope (Space)
The volume of space within which the Manipulator can perform given tasks.
Appendix B

**Work Home Position**
The Work Home Position is a reference point for Manipulator operations. It prevents interference with peripheral device by ensuring that the Manipulator is always within a set range as a precondition for operations such as starting the line. The Manipulator can be moved to the set Work Home Position by operation from the Programming Pendant, or by signal input from an external device. When the Manipulator is in the vicinity of the Work Home Position, the Work Home Position signal turns ON.

**Work Piece**
Any part which is being worked, refined or manufactured prior to its becoming a finished product.

**Workspace**
The volume of space within which the Manipulator can perform given tasks.

**World Coordinates**
A reference coordinate system in which the Manipulator arm moves in linear motions along a set of Cartesian or rectangular axes in X, Y, and Z directions. The shape of the work envelope forms a rectangular figure. See "Rectangular-Coordinate Robot".

**World Model**
A three dimensional representation of the Manipulator's work environment, including objects and their position and orientation in this environment, which is stored in Manipulator memory. As objects are sensed within the environment the Controller system continually updates the World Model. Manipulators use this World Model to aid in determining its actions in order to complete given tasks.

**Wrist**
A set of rotary joints between the arm and the Manipulator end-effector that allow the end-effector to be oriented to the work-piece. In most cases the wrist can have degrees of freedom which enable it to grasp an object with roll, pitch, and yaw orientation. See "End-effector", "Roll", "Pitch", "Yaw" and "Work Piece".

**Wrist [Secondary Axis]**
An interconnected set of links and powered joints between the arm and end-effector, which supports, positions and orientates the end effector. (ISO 8373)

**X**

**Y**

**Yaw**
Rotation of the end-effector in a horizontal plane around the end of the Manipulator arm. Side to side motion at an axis. See "Roll" and "Pitch".

**Z**
MLX300
HARDWARE INSTALLATION, SOFTWARE UPGRADE AND OPTIONS
INSTRUCTIONS

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